

hydrogen atoms. Hydrocarbons may also include other elements, such as, but not limited to, halogens, metallic elements, nitrogen, oxygen, and/or sulfur. Hydrocarbons may be, but are not limited to, kerogen, bitumen, pyrobitumen, and oils. Hydrocarbons may be located within or adjacent to mineral matrices within the earth. Matrices may include, but are not limited to, sedimentary rock, sands, siliclytes, carbonates, diatomites, and other porous media.

[On page 64, please delete the paragraph beginning on line 11, and substitute therefor:]

As shown in FIG. 3, in addition to heat sources 100, one or more production wells 104 will typically be disposed within the portion of the coal formation. Formation fluids may be produced through production well 104. Production well 104 may also include a heat source. In this manner, the formation fluids may be maintained at a selected temperature throughout

[C2] production, thereby allowing more or all of the formation fluids to be produced as vapors. Therefore, high temperature pumping of liquids from the production well may be reduced or substantially eliminated, which in turn decreases production costs. Providing heating at or through the production well tends to: (1) inhibit condensation and/or refluxing of production fluid when such production fluid is moving in the production well proximate to the overburden, (2) increase heat input into the formation, and/or (3) increase formation permeability at or proximate the production well.

**In The Claims:**

Listed below is a clean copy of the amended claims. A marked-up copy indicating the amended sections of the claims is provided in an accompanying document.

Please amend the claims as follows:

*SUPER*  
2270. (Amended) A method of treating a hydrocarbon containing formation *in situ*, comprising: providing heat from one or more heaters to at least a portion of the formation; and

Sub E1

allowing the heat to transfer from the one or more heaters to a selected section of the formation such that a porosity of a majority of at least a portion of the selected section increases substantially uniformly.

Sub F1

2271. (Amended) The method of claim 2270, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least two heaters pyrolyzes at least some hydrocarbons within the selected section of the formation.

2272. (Amended) The method of claim 2270, further comprising maintaining a temperature within the selected section within a pyrolysis temperature range, wherein the pyrolysis temperature range is from about 250 °C to about 370 °C.

2273. (Amended) The method of claim 2270, wherein the one or more heaters comprise electrical heaters.

2274. (Amended) The method of claim 2270, wherein the one or more heaters comprise surface burners.

2275. (Amended) The method of claim 2270, wherein the one or more heaters comprise flameless distributed combustors.

2276. (Amended) The method of claim 2270, wherein the one or more heaters comprise natural distributed combustors.

2279. (Amended) The method of claim 2270, wherein providing heat from the one or more heaters to at least the portion of formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from the one or more heat sources, wherein the formation has an average heat capacity (C<sub>v</sub>), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

Sub D2  
Q4

wherein heating energy/day ( $P_{wr}$ ) provided to the selected volume is equal to or less than  $h*V*C_v*\rho_B$ , wherein  $\rho_B$  is formation bulk density, and wherein an average heating rate ( $h$ ) of the selected volume is about 10 °C/day.

Sub 031  
C5 2281. (Amended) The method of claim 2270, wherein providing heat from the one or more heaters comprises heating the selected section such that a thermal conductivity of at least a portion of the selected section is greater than about 0.5 W/(m °C).

Sub 041  
C6 2283. (Amended) The method of claim 2270, further comprising producing a mixture from the formation, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component.

Sub 041  
C6 2304. (Amended) The method of claim 2270, further comprising substantially uniformly increasing a permeability of a majority of the selected section.

Sub 041  
C8 2306. (Amended) The method of claim 2270, further comprising producing a mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

2307. (Amended) The method of claim 2270, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heat sources, and wherein the unit of heaters comprises a triangular pattern.

2308. (Amended) The method of claim 2270, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heat sources, wherein the unit of heaters comprises a

*CS*  
*Scopy*

~~triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.~~

*Subj 1* *40* *39*  
5396. (Amended) The method of claim 2306, wherein at least about 20 heaters are disposed in the formation for each production well.

*Subj 5* *C10*  
Please add the following claims:

5397. (New) ~~A method of treating a hydrocarbon containing formation in situ, comprising:~~  
providing heat from one or more heaters to at least a portion of the formation; and  
allowing the heat to transfer from one or more heaters to a part of the formation such that a porosity of a majority of the part increases substantially uniformly.

5398. (New) The method of claim 5397, wherein the part comprises a pyrolysis zone.

5399. (New) The method of claim 5397, wherein the part comprises a pyrolysis zone proximate to and/or surrounding at least one heater.

*Subj 1* *44*  
5400. (New) The method of claim 5397, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least two heaters pyrolyzes at least some hydrocarbons within the part of the formation.

*Subj 5* *41*  
5401. (New) The method of claim 5397, further comprising maintaining a temperature within the part within a pyrolysis temperature range, wherein the pyrolysis temperature range is from about 250 °C to about 370 °C.

*Subj 7*  
5402. (New) The method of claim 5397, wherein the one or more heaters comprise electrical heaters.

5403. (New) The method of claim 5397, wherein the one or more heaters comprise surface burners.

5404. (New) The method of claim 5397, wherein the one or more heaters comprise flameless distributed combustors.

5405. (New) The method of claim 5397, wherein the one or more heaters comprise natural distributed combustors.

5406. (New) The method of claim 5397, wherein the one or more heaters comprise natural distributed combustors, the method further comprising allowing oxidizing fluid to react with at least some hydrocarbons within a reaction zone to generate heat in the reaction zone and transferring the generated heat substantially by conduction from the reaction zone to the part.

SubD  
C16  
5407. (New) The method of claim 5397, further comprising controlling a pressure and a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

SubD  
5408. (New) The method of claim 5397, further comprising controlling the heat such that an average heating rate of the part is less than about 1 °C per day during pyrolysis.

SubD  
5409. (New) The method of claim 5397, wherein providing heat from the one or more heaters to at least the portion of formation comprises:

heating a selected volume (V) of the hydrocarbon containing formation from the one or more heat sources, wherein the formation has an average heat capacity (C<sub>v</sub>), and wherein the heating pyrolyzes at least some hydrocarbons within the selected volume of the formation; and

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than  $h*V*C_v*\rho_B$ , wherein  $\rho_B$  is formation bulk density, and wherein an average heating rate (h) of the selected volume is about 10 °C/day.

Sub F17  
Rule 126

5410  
5411

5397. (New) The method of claim 5397, wherein allowing the heat to transfer comprises transferring heat substantially by conduction.

Sub D7

5411  
5398. (New) The method of claim 5397, wherein providing heat from the one or more heaters comprises heating the part such that a thermal conductivity of at least a portion of the part is greater than about 0.5 W/(m °C).

Sub F17  
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5399. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

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5400. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 0.1 % by weight to about 15 % by weight of the condensable hydrocarbons are olefins.

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5401. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises non-condensable hydrocarbons, and wherein a molar ratio of ethene to ethane in the non-condensable hydrocarbons ranges from about 0.001 to about 0.15.

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5402. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is nitrogen.

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5403. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is oxygen.

*Rule 12b*  
*Subj D*  
*5417*  
*41*  
5404. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is sulfur.

*62*  
*5418*  
*41*  
5405. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons comprise oxygen containing compounds, and wherein the oxygen containing compounds comprise phenols.

*5419*  
*41*  
5406. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein greater than about 20 % by weight of the condensable hydrocarbons are aromatic compounds.

*5420*  
*41*  
5407. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 5 % by weight of the condensable hydrocarbons comprises multi-ring aromatics with more than two rings.

*5421*  
*41*  
5408. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 0.3 % by weight of the condensable hydrocarbons are asphaltenes.

*5422*  
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5409. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons are cycloalkanes.

*5423*  
*41*  
5410. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises a non-condensable component, wherein the non condensable component comprises molecular hydrogen, wherein the molecular hydrogen is

*Sub A)*  
*Rule 12a*  
greater than about 10 % by volume of the non-condensable component, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component.

*5424 68 41*  
5411. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises ammonia, and wherein greater than about 0.05 % by weight of the produced mixture is ammonia.

*5425 41*  
5412. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein the produced mixture comprises ammonia, and wherein the ammonia is used to produce fertilizer.

*5426 70 41*  
5413. (New) The method of claim 5397, further comprising controlling a pressure within at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute.

*5427*  
5414. (New) The method of claim 5397, further comprising controlling formation conditions to produce a mixture from the formation, wherein a partial pressure of H<sub>2</sub> within the mixture is greater than about 0.5 bar.

*5428*  
5415. (New) The method of claim 5397, further comprising producing a mixture from the formation, wherein a partial pressure of H<sub>2</sub> within the mixture is measured when the mixture is at a production well.

*5429*  
5416. (New) The method of claim 5397, further comprising altering a pressure within the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25.

*5430 41*  
5417. (New) The method of claim 5397, further comprising producing a mixture from the formation and controlling formation conditions by recirculating a portion of hydrogen from the mixture into the formation.

Sub D16 5431

5418. (New) The method of claim 5397, further comprising:  
providing hydrogen (H<sub>2</sub>) to the heated section to hydrogenate hydrocarbons within the section; and  
heating a portion of the section with heat from hydrogenation.

Rule 126

75 Sub 5432

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5419. (New) The method of claim 5397, further comprising:  
producing hydrogen and condensable hydrocarbons from the formation; and  
hydrogenating a portion of the produced condensable hydrocarbons with at least a portion of the produced hydrogen.

Sub D17 5433

5420. (New) The method of claim 5397, wherein allowing the heat to transfer comprises increasing a permeability of a majority of the part to greater than about 100 millidarcy.

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5421. (New) The method of claim 5397, further comprising substantially uniformly increasing a permeability of a majority of the part.

Sub D18 5435

5422. (New) The method of claim 5397, further comprising controlling the heat to yield greater than about 60 % by weight of condensable hydrocarbons, as measured by the Fischer Assay.

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5423. (New) The method of claim 5397, further comprising producing a mixture in a production well, and wherein at least about 7 heaters are disposed in the formation for each production well.

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5424. (New) The method of claim 5423, wherein at least about 20 heaters are disposed in the formation for each production well.

Sub D17 5438

5425. (New) The method of claim 5397, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in

*Sabat* 17 the formation in a unit of heat sources, and wherein the unit of heaters comprises a triangular pattern.

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*R.Je126* 5426. (New) The method of claim 5327, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heat sources, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

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*Sabat* 5427. (New) A method of treating a hydrocarbon containing formation in situ, comprising: providing heat from one or more heaters to at least a portion of the formation, wherein one or more heaters provides a heat output of less than about 1650 watts per meter; and allowing the heat to transfer from one or more heaters to a part of the formation such that a porosity of a majority of at least a portion of the part increases substantially uniformly.

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*C13* 5428. (New) The method of claim 5427, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least two heaters pyrolyzes at least some hydrocarbons within the part of the formation.

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5429. (New) The method of claim 5427, further comprising maintaining a temperature within the part within a pyrolysis temperature range, wherein the pyrolysis temperature range is from about 250 °C to about 370 °C.

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5430. (New) The method of claim 5427, further comprising controlling a pressure and a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

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5431. (New) The method of claim 5427, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

Rule 12 b 5445 5440  
5432. (New) The method of claim 5427, further comprising controlling a pressure within at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute.

5446 5440  
5433. The method of claim 5427, wherein the part of the formation comprises a selected section.

5447 5440  
5434. The method of claim 5427, wherein the part of the formation comprises a pyrolysis zone.

5448 5440  
5435. The method of claim 5427, wherein the part of the formation comprises a pyrolysis zone proximate to and/or surrounding at least one of the one or more heaters.

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5436. (New) A method of treating a hydrocarbon containing formation in situ, comprising:  
C10 providing heat from one or more heaters to at least a portion of the formation; and  
allowing the heat to transfer from one or more heaters to a part of the formation such that an assessed porosity of any portion of the part does not vary by more than about 25 % from an assessed average porosity of the part.

5450 5449  
5437. (New) The method of claim 5436, wherein a porosity of a majority of the part of the formation increases substantially uniformly.

5451 5449  
5438. (New) The method of claim 5436, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least two heaters pyrolyzes at least some hydrocarbons within the part of the formation.

5452 5449  
5439. (New) The method of claim 5436, further comprising maintaining a temperature within the part within a pyrolysis temperature range, wherein the pyrolysis temperature range is from about 250 °C to about 370 °C.

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5440. (New) The method of claim 5436, further comprising controlling a pressure and a temperature within at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

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5441. (New) The method of claim 5436, further comprising producing a mixture from the formation, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

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5442. (New) The method of claim 5436, further comprising controlling a pressure within at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 bar absolute.

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5443. (New) The method of claim 5436, wherein the part comprises a pyrolysis zone.

C 10

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5444. The method of claim 5436, wherein the part comprises a pyrolysis zone proximate to and/or surrounding the two or more heaters.

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5445. (New) A method of treating a hydrocarbon containing formation in situ, comprising: providing heat from at least two heaters to at least a portion of the formation; and allowing the heat to transfer from at least two heaters to a part of the formation such that superposition of heat from at least two heaters pyrolyzes at least some hydrocarbons within the part and increases porosity in the part.

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5446. (New) The method of claim 5445, wherein the porosity of a majority of the part increases substantially uniformly.

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5447. (New) The method of claim 5445, wherein the part comprises a pyrolysis zone.

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5448. (New) The method of claim 5445, wherein the part comprises a pyrolysis zone proximate to and/or surrounding the heaters.